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A Report of Papers and Discussions
Presented by the Southern Utilization Research Branch

Introductury Remarks

by
C. H. Fisher, Chief
Southern Utilization Research Branch

It is a privilege and a pleasure to welcome our guests to this Laboratory. We are happy to have you with us. This meeting is unique because it is the first time that we have had the cottonseed and soybean oil millers in one meeting in New Orleans. I think it appropriate that representatives of the two industries are meeting together because the problems of both groups have much in common. We hope this meeting shall prove profitable to both groups.

We should like to extend a special welcome to the members from the soybean oil mills since this is their first trip to our Laboratory. Our guests from the cottonseed industry are old friends of ours. We are pleased also to have with us Dr. Fetrow, representatives from the NorthernUtilization Research Branch, and our other guests.

I shall attempt to bring to your attention news that may be of general interest to you. We are pleased because Richard Hall, a representative of the Agricultural Marketing Service, has been stationed at this Laboratory. Richard Hall has replaced Marshall Miller, who was the first AMS representative stationed here, and who has since been assigned an important position in Washington. We believe that this close liaison with AMS will help and facilitate our research.

Perhaps some of you know that Al Kime is leaving us to join the Department of Defense at Frederick, Md. We shall all miss Al. Not only has he made important contributions to the work of the Branch but he also has taken an active part in arranging and participating in the meetings of the Cottonseed Oil Millers.

We appreciate your coming and we hope that you will enjoy and benefit from your stay in New Orleans.

Variations in Chemical Characteristics and Nutritive Value of Commercial Cottonseed Meals

by A. M. Altschul

The purpose of this discussion is to present a brief review of what we are doing in trying to improve the nutritive value of cottonseed meal for poultry and swine. I will mention only briefly several other lines of work. We are conducting research, in cooperation with the Engineering and Development and the Analytical and Physical Sections, on development of new approaches to cooking of cottonseed to yield higher quality oil and meals. This is an outgrowth of laboratory work which indicated that cooking of cottonseed at high moisture contents and with the addition of alkali seems to improve both the oil and the meal. Other work is on improving the color of cottonseed oil by studying the reactions of gossypol in the oil and the development of pigmented materials on storage. The subjects which I will discuss in greater detail are our study of commercial cottonseed meals in cooperation with the National Cottonseed Products Association and our work on developing better chemical methods of characterizing the nutritive value of cottonseed meals, also in cooperation with the NCPA.

Considerable progress has been made in understanding the processing variables which affect meal quality, and many meals suitable for feeding to poultry and swine have been produced. Indeed, in 1954, it is estimated that approximately 250 thousand tons of cottonseed meal went into poultry and swine markets. With all this background of progress, the time had come to take stock of the present processing of cottonseed to compare the relative merits of meals produced by the various commercial processes. Accordingly, plans were made for collection of typical meals made by the various methods of processing and their evaluation in a standard nutritional test to be conducted by a number of laboratories, Federal, State and commercial. A

fellow of the National Cottonseed Products Association, Mr. Biagio Piccolo, was assigned to assist in carrying out this experiment. Close to 50 commercial meals were analyzed and then typical meals of the various classes were selected. There will be included 3 screw-press meals representing light, medium, and extreme processing conditions. There will be 2 prepress solvent extraction meals representing two levels of intensity of processing. There will also be a straight solvent-extracted meal, a hydraulic press meal, and a chemically-degossypolized meal. All these meals are now being collected. The diets containing these meals will be mixed in one operation through the help of the Ralston-Purina Co. The mixed feeds will be sent to nutrition investigators during the month of April.

Complete chemical data are being taken on all of the meals so that there will be ample opportunity for correlation between chemical properties and nutritive value. The Soybean Research Committee is cooperating by providing a standard soybean meal to be used as a comparison in many of the experiments, and in mixture with cottonseed meal in various proportions in all of the experiments.

The results of this investigation, which will take a year or so to assemble, should have a profound influence on the pattern of use of cottonseed meal in the future and may affect the future of various processing techniques as it indicates those which produce meals of superior quality and enhance economic value.

Nitrogen solubility in dilute alkali is now being used to measure the extent of heat damage suffered by the meal during processing. This is a very useful criterion. In an attempt to improve upon it so that the results of different processing conditions can be assessed, considerable research work is being done on the chemical properties of cottonseed meals. This work has the further value of finding what actually happens chemically to meals produced by

different methods of processing. Such information might well serve as the clue for the development of improved methods of processing.

One of the outcomes of this investigation has been finding that solubility in strong acid parallels the results of solubility in dilute alkali and in many instances gives a more accurate representation of processing history. It is not proposed that solubility in acid should substitute or supplant the present use of solubility in alkali. Both suffer from the fact that they are empirical measures.

We have the feeling as we look upon our program at the present time that by virtue of closer chemical examination of the meals we are coming closer to an understanding of actually what is happening during processing. We have the feeling that we should shortly be able to understand why meals differ in their nutritive value as a result of processing conditions, and how one process differs from the other in its effect on the meals. This basic information should take us out of the class of operating in the dark and make it possible to apply chemical information to the planning of processing programs with the ultimate aim of producing meals of improved nutritive value and higher economic value.

THE COLOR PROBLEM IN COTTONSEED OIL

By: V. L. Frampton

I -- The Problem

The color problem in cottonseed oil developed because of the discrimination of the user against dark colored oils, and because of the difficulty in removing some of the pigments in dark colored oil by the current refining and bleaching processes.

This color can develop in crude cottonseed oils that have been stored too long at elevated temperatures, or it can develop in aged cottonseed, or the colored constituents may be present in field damaged or immature cottonseed.

The problem we are faced with is that of preventing the development of pigments, in crude cottonseed oil, which cannot be removed by the conventional processes, and/or developing means whereby undesirable colored materials can be removed economically from oil that has become colored for any reason, e.g., because of field damage to the seed, because of immaturity in some of the seed processed, because of age of the seed, or because the refining of oil from prime seed has been delayed.

II — CHEMISTRY OF COLOR DEVELOPMENT

The evidence which we have at the present time indicates that the major coloration in cottonseed oil owes its origin to gossypol. The evidence supporting this view is summarized:

1. The removal of acidic materials via alkaline refining very soon after the oil from prime seed has been extracted from cottonseed results in a product in which no serious pigment fixation occurs, while if the acidic materials are not removed, fixation of pigments occur; that is, pigments develop in the oil which are then not removed by the conventional procedures. Gossypol-like compounds

are among the acidic constituents in cottonseed oil which are removed by alkali refining.

2. When para-aminobenzoic acid is added to the freshly extracted oil, and the insoluble reaction products are removed, then there is also a retardation in formation of pigments that cannot be removed by alkali refining and the current bleaching methods. Gossypol is chemically bound in the precipitate and it is removed from the oil as an insoluble Schiff base.

3. There is a linear relationship between the increase in bleach color upon storage of the crude oil and the initial gossypol pigments content of the crude oil.

4. The decrease in the gossypol content of the pigment glands that occurs during the storage of cottonseed, and the increase in the intensity of red and purple pigmentation, is related to the increase in the color of refined and bleached oil from old seed. It is presumed that the darker coloration which occurs in stored seed is due to the chemical modification of gossypol, during storage, to yield oil-soluble pigments.

The working hypothesis that forms the basis of our present thinking is that the pigments which give rise to the more serious of the color problems in cottonseed oil are derived from gossypol, or from materials in the seed and in the oil extracted therefrom that are similar to gossypol in their behavior.

As a matter of fact, some of the pigments which are known to be derived from gossypol could very well contribute to the coloration in refined and bleached cottonseed oil, since they probably are resistant to

alkali refining. For example, the yellow pigment diaminogossypol, which apparently occurs naturally, is alkali insoluble and will not be removed from organic solvents by the action of dilute sodium hydroxide. Gossypurpurin, which occurs naturally, is converted to a yellow material by the action of alkali, and this yellow material is not readily removed from organic solvents by the action of dilute alkali. In addition, an orange pigment, gossyfulvin, and a blue pigment, gossycaerulin, have been isolated from cottonseed products. It is possible that some of these materials are responsible, in part, for the pigmentation in colored oils.

Diaminogossypol and gossypurpurin are nitrogen containing pigments which are formed in the pigment glands of the cottonseed during storage, and they may occur in freshly harvested cottonseed. Thus, it has been observed that the seeds in bolls from the lower regions of a plant will contain more darkly colored pigment glands than those from the upper part of the same plant. These two pigments are derived from gossypol, and gossypol can be obtained from each of them through the action of mineral acid.

Gossyfulvin is an orange pigment that seems to develop in cottonseed flakes when they are cooked under low moisture conditions as, for example, in the cooking utilized in the screw press operations. This is a nitrogen containing pigment which is insoluble in alkali and, therefore, is not removed from cottonseed oil through the alkali refining methods now being used. Gossypol can also be obtained from this pigment through the action of mineral acids.

The pigments referred to above are probably not oxidation products of gossypol. A fourth pigment, gossycaerulin, which is blue, probably is an oxidation product of gossypol. Gossypol has not been obtained from this

pigment. This pigment is probably a hydroxy quinone; it is an indicator, and is removable from organic solvents by aqueous alkali. It probably does not contribute to the pigmentation of cottonseed oil, since it can be removed from the oil by the alkaline refining process.

Although we strongly believe it to be so, we cannot categorically state that gossypol-like pigments are the sole origin of the pigmentation because there are other aromatic materials in cottonseed oil that can give rise to pigments that will not be removed by the conventional refining and bleaching processes. The tocopherols, for example, give rise to yellow, blue, orange, purple and red pigments when they are subjected to mild oxidation agents as, for example, iron in the ferric form. Any substance present in cottonseed oil that can be converted to a quinone or to a hydroxy quinone will give rise to colored materials that probably cannot be removed by the conventional methods for processing crude cottonseed oil. It is presumed that gossypol may be converted into a number of different quinones and, therefore, gossypol-like pigments are suspected. The oxidation of gossypol to quinoid substances has been demonstrated only in a qualitative way, e.g., reddish coloration products are obtained when gossypol is subjected to the action of some mild oxidizing agents, and the color can be bleached by the action of a reducing agent, such as metallic zinc and hydrochloric acid.

Some such oxidations might be mentioned. Coloration develops when gossypol is mixed with a copper-amine complex, and then air is admitted to the resultant solution. The colors are usually red or deep orange. The red or orange color can be bleached to yield a yellow color by the action of metallic zinc in the presence of acid, and the red coloration develops again

by the action of atmospheric oxygen when the zinc is removed by filtration, and the acid is neutralized. The mixture of yellow pigments developed on reduction does not contain gossypol. Some of the red or orange coloration products are indicators, e.g., the color changes on changing the solution from the alkaline to acid state by the addition of alkali or acid, as the case may be.

Nitromethane brings about the oxidation of gossypol to yield a purple material, which is also an indicator. This pigment is purple in an alkaline medium and yellow in an acid medium. The yellow product is not gossypol.

A red colored product is produced by the action of hydrogen peroxide or of peracids on gossypol. This red coloration is transitory in the presence of an excess of peroxide or per acid, and it is transformed to a colorless product.

III — PRESENT RESEARCH AT SRRL

The present work undertaken at SURB on color in cottonseed oil involves (1) experimentation in cooking and (2) an investigation of the quinoid oxidation materials that can be derived from gossypol. In the case of the cooking experimentation, the evidence is that the presence of aqueous alkali during the cooking reduces the quantities of pigment in the fresh oil, and the crude oil from this cooking procedure may be stored for prolonged periods of time under adverse conditions without the development of undesirable pigments.

The work on the cooking program is based on the assumption that the best way to deal with the color problem is to keep the precursors of the dark pigments out of the oil. It is hoped that we may be able to fix in

the meal some of the components which enter into the reactions which produce the undesirable colors.

Such a fixation cannot be achieved in many cases because of the fact that oil soluble pigments are formed in the seed, and they are present before the oil is removed. The investigations being carried out at the present time are based upon the assumption that some of the reddish and brown colored materials in colored oils are quinoid in character, specifically, that they are ortho quinones, and that they arise from the dehydrogenation or the oxidation of gossypol.

IV — PROPOSED PROGRAM FOR RESEARCH

A program of research aimed at the elimination of the color problem in cottonseed oil should concern itself with: (1) the prevention of color development in the oil and (2) the development of practical means of removing the color should it be formed. The program, aimed at a practical solution of the problem, should involve basic and applied research, as necessary. Such a program, which would be expected to yield tangible results with the minimum of effort, is itemized in the following outline:

1. Gossypol as a Source of Color: It is desired to know the reactions gossypol enters into with other constituents that are known to be present in the oil, or with constituents which are suspected as being present. It is desired to know the effects of time and temperature on these reactions, and to know the means of preventing them. A knowledge of the chemistry of the colored reaction products of gossypol will serve as a

guide in the development of new refining and bleaching methods for oils which are inherently dark or which have become dark because of pigment fixation after they have been removed from the seed.

The item of highest priority in this category, in our opinion, is the following:

(a) A study of the products obtained upon the mild oxidation of gossypol in various solvents, including cottonseed oil; in particular, those oxidations which give rise to colored products. This is important because knowledge of the behavior of these products will serve as a guide in the development of methods of refining and bleaching which will be effective in the removal of the colored products from the colored cottonseed oil obtained from bad or damaged seed, or from oil in which pigmentation has become fixed.

Other lines of work in this category would include:

(b) The chemistry of gossypol, including its degradation, synthesis and its chemical reactions.

(c) Study of the pigments related to gossypol in the pigment glands, seed, meal and oil.

(d) Study of the reactions of gossypol with naturally-occurring amines.

(e) Study of pigments from damaged cottonseed, such as immature, field damaged and storage damaged seed.

(f) Study of pigments other than those derived from gossypol.

2. Removal of Gossypol from Fresh Oil. The item of highest priority in this category is:

   The development of practical procedures for the removal of gossypol or gossypol derivatives from freshly extracted oil. Whereas alkali refining is effective in this regard, it is possible that improvements might be made through the addition of a material which has an affinity for gossypol and gossypol derivatives, and which will yield a product that is readily removed from the oil. It is envisioned that the material can be added to the oil immediately as it comes from the solvent stripper or from the press.

Note: Laboratory procedures to accomplish the above-mentioned objective have already been devised.

3. New-Type Cooking to Prevent Color Bodies from Being Extracted with the Oil. This involves primarily a study of the effect of the variation in moisture content and presence of other solvents and additives on the pigmentation of the oil. Two lines of research in this category are the following:

   (a) Development of practical methods of cooking in the presence of high moisture and alkali.

   Preliminary indications are that such an approach has promise, but it remains to be determined whether it can be made practical.

   (b) Laboratory investigations of alkali and solvents as additives in the cooking of cottonseed.

Note: Preliminary investigations have indicated that free-gossypol can be eliminated from meal and oil by such a procedure.

4. Improvements in Refining and Bleaching. The item of highest priority in this category is:

(a) The use of new adsorbants for the bleaching of refined oil, and the possible activation of the colored bodies so that they would adsorb more readily. Some such activation agents such as ultrasonic vibrations, radiation with alpha, beta or gamma rays, etc., might be tried. This is admittedly a long-shot gamble, but certainly should be considered.

Other lines of work in this category are:

(b) The use of additives in refining, or changes in refining procedures. Something might be found, for example, that would precipitate the colored bodies not removed by alkali, so that they would be filtered from the oil. A judicious selection of such agents would be helped by our knowledge of the chemistry of the colored bodies.

(c) The isolation and characterization of the pigments from unbleachable oil. This is a very difficult task, but it is one which might be carried out with profit.

V -- SUGGESTIONS FOR POSSIBLE EXPANSION OF WORK

(a) At Southern Utilization Research Branch:

The role of gossypol in the pigmentation in cottonseed oil should be settled and the development of practical methods for controlling color due to gossypol reactions should be attained as quickly as possible. This means

that the present effort under the high-priority item of category 7(a) should be expanded with skilled personnel. This is probably the key to the entire problem and deserves the foremost attention. In the final analysis, this is the most practical approach.

(b) At Southern Utilization Research Branch or University Laboratories:

Any progress in solving the practical problems involving the pigments depends upon our skill in handling gossypol, and on the available information on its chemistry. Work such as that of Dr. David Shirley at the University of Tennessee on the structure of gossypol and by Dr. H. R. Henze at the University of Texas on the reactions of gossypol should be encouraged because it contributes the type of information needed for practical solutions. Work of this type can also be done at SURB.

(c) By Contract with Other Research Groups:
(Funds for some contract research are available at SURB)

1. The demonstration that removal of gossypol from fresh crude oil prevents color reversion and development of unbleachable pigments is of far-reaching importance. That no practical method yet exists for doing so (with the exception of immediate refining) does not mean that this is impossible of attainment. A contract to develop a practical method for use in a crude oil mill might well succeed in solving this problem. This lead should be followed before turning to other approaches.

2. Another possibility for contract research is in exploring new approaches to bleaching. This would include investigation of new adsorbants and resins and of chemical and physical methods of increasing the activity and "adsorbability" of the unbleachable pigments.

DISCUSSION

Whittecar: Can you bleach out the red color of the oxidation product of gossypol?

Frampton: Yes.

Davis: Why must everything be white? Perhaps a yellow oil would be better.

Frampton: The purchaser is the one who decides. He needs the lightest colored oil possible for manufacture of the lightest colored food products. The trend is to lighter colored oils. I don't know whether the physiological properties of a yellow oil are better or worse than those of a lighter colored oil.

Davis: A few years ago everybody wanted to make the whitest flour possible. They have done the same thing with rice. Yet the whiter they make them, the lower are their nutritive qualities. Today, bread made from white flour has to be enriched. Couldn't it be that yellow cottonseed oil is richer in certain vitamins or other nutritive components that are not present in the lightest oil?

Frampton: The yellow colors of some foods such as butter or carrots are due to carotene. The yellow color in corn is a precursor to Vitamin A; but in cottonseed oil, the yellow color is due to other pigments.

Davis: How do you know that the materials removed from an oil during alkali-refining are not good for the animal?

Frampton: We know that gossypol, the yellow pigment, is toxic.

Altschul: I believe that industry has created the demand for the lightest colored products. In advertising, the industry has

associated purity with whiteness. You have seen what advertising has done to convince the housewife that white flour and white rice are better products even though their vitamin contents have been lowered as a result of producing the white products. A reversal could be made by the industry to indicate that yellowness is good. However, there are minor constituents in cottonseed oil about which we know very little.

Davis: I believe that cottonseed oil containing lecithin would be better nutritionally than the present refined and bleached oil.

Altschul: Do we know how good lecithin in an oil is?

Davis: When we remove lecithin and other constituents, the refining loss is increased and the residual oil color is increased.

Altschul: The minor constituents in the oil and their importance have have never been determined. That is one thing that we have to work out later. Concerning the lecithin question, much has been said about the role of animal versus vegetable fats in the human body, and their effect upon increasing the amount of body cholesterol, and their role in causing arteriosclerosis. It may be that some minor constituents such as phosphatides in the oil may be shown to have a profound effect on acute toxicity, heart disease, cancer, etc. But with the statements being published about such facts, the results are not too conclusive. There is still a lot more to be learned about such matters. That is why we cannot say how important the minor constituents of the oils are.

Davis: Is P & G's "Fluffo" made from a highly colored vegetable oil, or has color been added to it?

Altschul: I believe that animal fat is a constituent of that product. The yellow color has been added to differentiate it from vegetable shortening.

Kime: I have been told that we must do something if we are to continue to use screw press oil, because of its dark color.

Gastrock: A ssuming that we know what we want to remain in oil and what what we want to remove, we have another problem. In processing, we don't always remove only what we want to remove, but in addition we remove other constituents, some of which are beneficial. Some of the minor oil constituents prevent rancidity and oxidation and we would not want to remove these desirable constituents. We can take two pathways toward solving the problem. Either find out exactly what we want to remove from the oils - and remove only that, or else remove the desirable and undesirable components at the same time, and then add back to the oils the desirable components.

Altschul: In the early days of nutrition, findings were limited to a single week's results and to acute toxicity reactions, in finding out whether the animal died or didn't die. But today nutritionists have gone further and are interested in chronic toxicity and what will happen to an animal in its later stages of life as a result of repeated dosage. Certain substances are poisonous because of their accumulative effects, and for that reason we try to remove gossypol or the gossypol - like pigments from the oils.

Hazelton: Mr. Kime, you mentioned about having trouble with color of screw-pressed oils. We have no color problem with screw-pressed oils.

Kime: Well then, what causes the poor color of certain screw-pressed oils? Is it due to frost damage, defoliation, or poor seed?

Cecil: So far this year we have received a couple of thousand tons of bolly cottonseed. When we refined oil without exposure to air, f.f.a. ran about 4.5% and every bit of the oil produced came out about 1.5 - 1.8 refined color. But our refining loss was extremely high, averaging about 6 percent. There must be some other factor between extraction and refining that causes the high loss.

Frampton: I think the oxygen in the system allows for the conversion of gossypol to the red colored oxidation product, and that is why the oils are darkly colored. There is also more evidence that gossypol is the culprit which causes dark oil colors. Dr. Dechary has found that if he treats freshly expressed cottonseed oil with p-aminobenzoic acid, and removes the oil-insoluble precipitate formed, the oil remains light colored and does not develop dark pigments upon subsequent storage.

Altschul: There are two methods of attack on this problem of oil color in screw-pressed oils. First, though, I don't think you should incriminate the screw presses. We have been experimenting with modifications of the screw press operations by which lighter colored oils and meals of higher nutritive value can be produced. The other method lies in chemical treatment. You have heard about the work of Dr. Dechary. We have other projects going on that deal with the addition of certain chemicals during cooking of the meats. Maybe by that

method we will be able to produce light colored oils and higher quality meals. I believe the place to solve the problem is in the seed - either by improved handling of seed or in the pressing operation. The last place to catch it satisfactorily is immediately after the oil is made.

Cecil: I don't think that when you run into such bolly seed as we now have that you can avoid the high refining loss such as we are experiencing.

Unknown: Have you made any studies concerned with the phosphorous contents of meals.

Altschul: We have been making a study of the phosphorous distribution in meals fractionated by Miss Jensen. If any of you are interested, we can take you to the laboratory where that study is being conducted and discuss those results further.

Denny: Is oil quality traceable to the amount of ammonia or nitrogen in the oil? Or is protein content of the meal traceable to hulls?

Frampton: It is probable that free amino acids in the seed are involved. The ammonia and protein fractions could give rise to trouble.

SAMPLING AND CARE OF SAMPLES

By
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Two important considerations in obtaining materials balances in the operation of oil mills are sampling and care of samples. It is essential that the samples of seed, meal, and oil be strictly representative of the lot of material in question, and that the samples be handled so that no change in moisture occurs or any change in moisture is known. Both of these considerations are of major importance in obtaining the most value from chemical analyses. The apparent "invisible loss" of "gain" in oil yields may in many cases be attributed to the loss or gain of moisture by the sample between the time of sampling and analysis.

The ideal procedure to assure that representative samples are obtained would be by means of automatic sampling, whereby numerous small portions of the material in question would be taken automatically at regular intervals and then composited and mixed. Of course, this type of sampling might not always be feasible and in such cases representative portions should be taken manually at frequent and regular intervals and composited to give the analytical sample. Adequate sampling is all the more difficult and important when dealing with cottonseed, due to the residual lint on the seed.

Proper care of samples of oilseed materials is equally as important as sampling. If the material is sampled at one moisture level and subsequently gains or loses moisture prior to analysis, erroneous mill balances will result unless the change in moisture content is taken into account. Therefore, the representative sample portions should be weighed at the time of sampling, and then kept in air-tight containers to prevent gain or

loss of moisture. Any change in moisture content can be ascertained by reweighing the sample just prior to its preparation for analysis.

The effects of improper sampling of seed and care of samples are illustrated by curves showing the variation of oil content, in percent and pounds per ton, with changes in moisture (Figure 1). The slopes of the lines are relatively steep, indicating a fairly large change in oil content or pounds of oil per ton for each unit change in moisture content. A one percent variation in moisture causes a change of approximately 4 pounds of oil, while a 1 percent variation in oil content results in a change of approximately 20 pounds of oil per ton. A specific example illustrates the possible errors in oil balances due to improper sampling or care of oilseed samples:

Assuming an oil content of 20 percent and a moisture content of 10 percent, there would be 360 pounds of oil per ton of oilseed. At 9 percent moisture there would be 364 pounds of oil per ton. Therefore, if the true moisture content should be 10 percent but the lower 9 percent value is obtained due to improper sampling or loss of moisture from the oilseed prior to analysis, 364 pounds of oil per ton will be anticipated but only 360 pounds will be accounted for in processing. An apparent "invisible loss" of 4 pounds of oil per ton will result. In the event that a non-representative portion of material is analyzed at the 10 percent moisture level and found to contain 21 percent oil rather than the true 20 percent, 378 pounds of oil per ton would be expected but only 360 pounds would be accounted for in processing. An "invisible loss" of 18 pounds of oil per ton will result. Variations in moisture and oil contents in the opposite direction will give apparent "gains" of oil of similar magnitude.

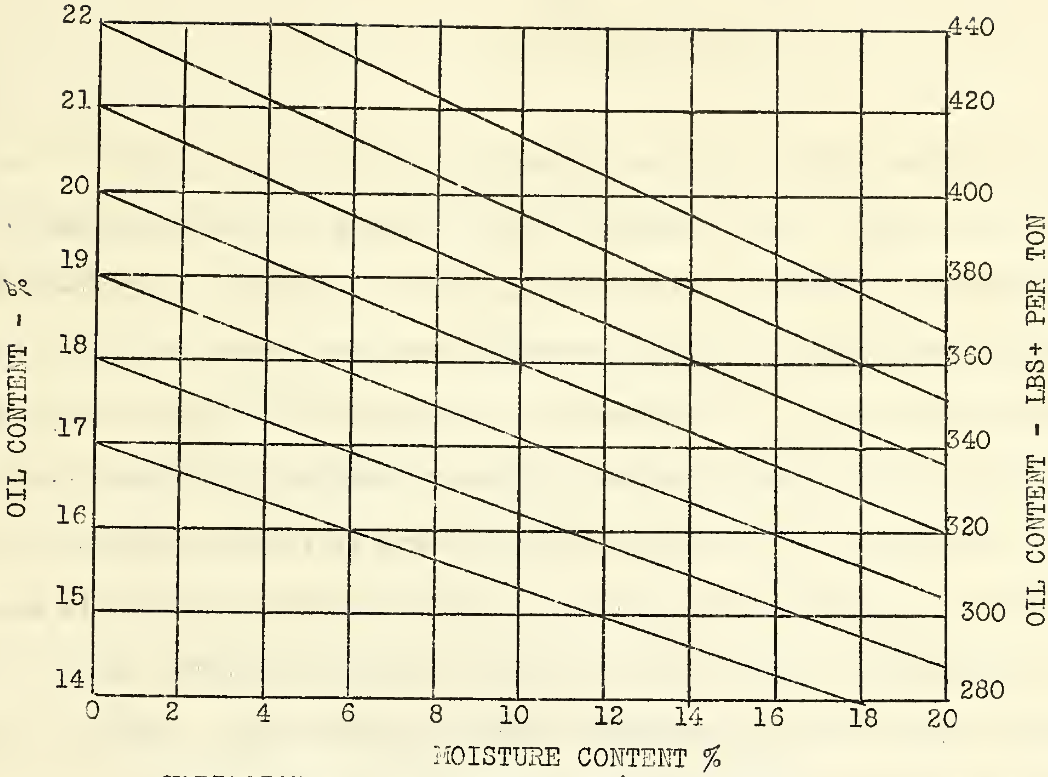
Similar curves are shown in Figure 2 to illustrate the possible errors caused by improper sampling and care of cake and meal samples. The slopes of the lines are not as steep as those in Figure 1, indicating smaller changes

in oil with variation of moisture. The following example illustrates the possible errors due to improper sampling or care of cake and meal samples:

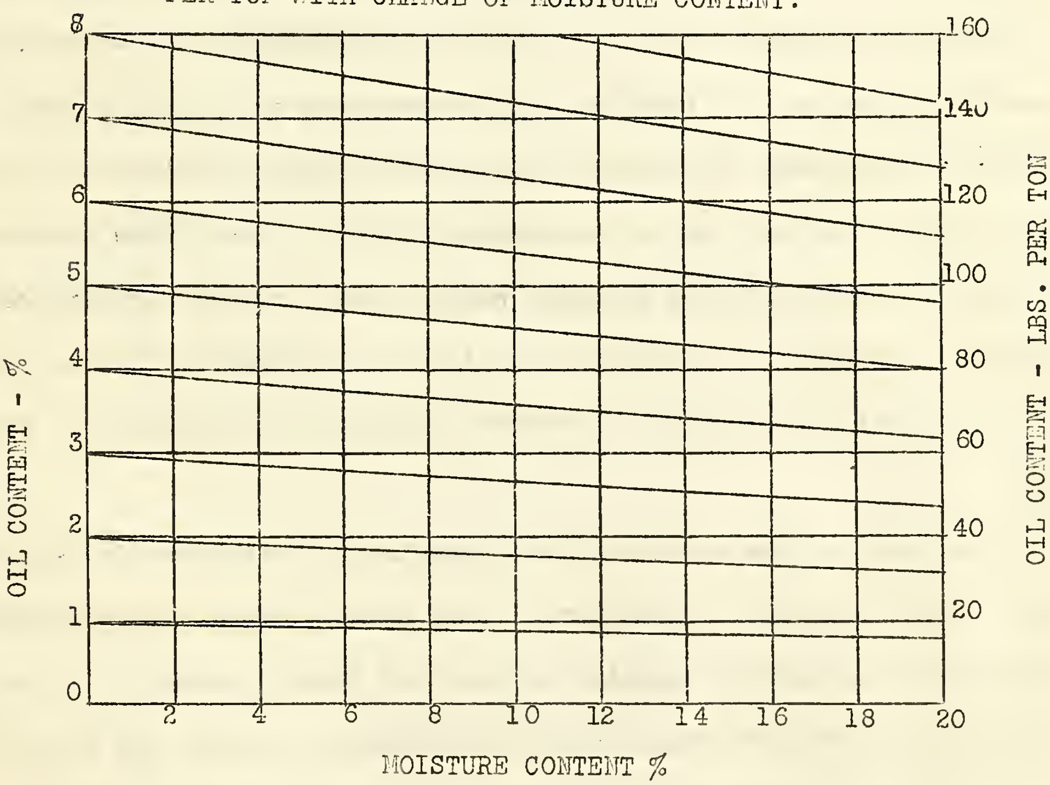
A sample of cake or meal containing 5 percent oil and 8 percent moisture would contain 92 pounds of oil per ton. At 9 percent moisture there would be only 91 pounds of oil per ton. Consequently, if the material is sampled at the 8 percent moisture content and subsequently improperly sampled or cared for prior to analysis such that a 9 percent moisture value is found, there would be an apparent "invisible loss" of 1 pound of oil per ton of material. Should a non-representative portion of cake or meal be analyzed and found to contain 4 percent oil, when the representative material actually contained 5 percent oil, this would result in an "invisible loss" of 18.4 pounds of oil per ton at the 8 percent moisture level.

The examples which have been cited serve to emphasize the following: (1) It is especially important in oil mill operations that the samples of seed, meal, and oil be representative of the lot of material in question. Representative sampling can best be achieved by automatic sampling procedures; (2) The samples should be handled so that no change in moisture occurs or any change in moisture is known and taken into account.

FIGURE 1



VARIATION OF OIL CONTENT IN % AND POUNDS
PER TON WITH CHANGE OF MOISTURE CONTENT.



VARIATION OF OIL CONTENT IN % AND POUNDS
PER TON WITH CHANGE OF MOISTURE CONTENT.

FIGURE 2

PROGRESS REPORT ON CLEANING COTTONSEED

By
L. L. Holzenthal

Experience gained with the traveling belt device (described at the March 1954 meeting of this group) for the cleaning of cottonseed led to experiments in which cottonseed were projected by means of a sling-shot device at a mugh higher velocity (8000-8500 feet per minute) than was attained with the conveyor belt. First studies of projection of individual particles of seed and of foreign matter components were made and then later castings of 100-pound lots of cottonseed by handful increments containing 3, 6, and 9% foreign matter. The results indicated that the seed and its contaminants were projected to a greater distance and were subjected to stronger combined effects of air friction and gravitation. This resulted in a more effective segregation and gradation of the various projected particles. The floor patterns thus attained shows possibilities of utilizing projection as a method for removing high percentages of typical foreign matter from cottonseed. The method also appears capable at the same time of fractionating the seed to an appreciable extent in accordance with seed size, meats, content, oil and nitrogen content, oil quality, linters content, and length of linters. Indications are also that the degree of final purity of the individual fractions can be further improved by supplementary reprojection.

On the basis of the results of the experiments using the sling-shot device, a continuous pilot plant machine has been designed and constructed which imparts high initial velocity to seed and foreign matter by means of high speed (7500-8500 feet/min.) dual belts arranged to grip and cast the

material. Presently the capacity and performance of this machine are under study and evaluation.

DISCUSSION

Whittecar: What do you expect to do with seed having a great amount of lint?

Holzenthal: Up to a distance of 10 feet in front of the Differentiator there is only trash and no seed, and up to 20 feet the seed which do appear consist of pops, poorly developed seed, and seed with shrivels and decayed kernels. The lint content can be recovered in a defibrating mill. There is only about 1 lb. of oil in the fraction up to 20 feet.

Gastrock: I believe the seed fraction from 10 to 20 feet will act the same in a linter machine by themselves or mixed with other seed. If they should shatter and increase contamination it would be better to process them separately.

Whittecar: What do you intend to do with that fraction having a high trash content and a high percentage of seed which is useless because of the high trash content?

Holzenthal: We contemplate investigating recycling as a means of handling this fraction.